DOCUMENT RESUME

ED 057 532 EC 040 766

AUTHOR Kaariainen, Risto
TITLE The Factor Structure of Intellectual Abilities and Signal Sight Vocabulary Learning at Moderate and Severe Levels of Preliterature Mental Retardation.
INSTITUTION Gothenburg School of Education (Sweden).
REPORT NO R-Bull-3
PUB DATE Jun 70
NOTE 61p.

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS *Cognitive Ability; Factor Structure; *Intelligence Level; *Mentally Handicapped; Reading Ability; Research Projects; Sight Vocabulary; *Trainable Mentally Handicapped

ABSTRACT

In order to study the signal-sight reading learning and the factor structure of intellectual abilities at preliterate moderate and severe levels of mental retardation (IQ 25-55), a test battery of items covering six hypothetical factors was constructed and administered to 80 preliterate mentally retarded subjects. The four factors extracted through factor analysis were called perceptual, memory-quantitative, psychomotor, and verbal-general. Analysis of the relationship between a learning variable (social sight learning) and intellectual factors showed that the perceptual factor had the highest positive correlation with the learning variable. Next highest correlations were found in the memory-quantitative and verbal factors. It was concluded that the findings agreed with those of previous factorial studies in showing that the one-dimensional IQ description of intelligence is not adequate to characterize the intellectual ability structure even on preliterate levels in the mentally retarded, since it is possible even on this level to secure a differentiated factor structure. (Author/KW)

ED057532

*The Scandinavian Research Group on Special Education*

Risto Kääriäinen

# THE FACTOR STRUCTURE OF INTELLECTUAL ABILITIES AND SIGNAL SIGHT VOCABULARY LEARNING AT MODERATE AND SEVERE LEVELS OF PRELITERATE MENTAL RETARDATION

EC 040 796

DEPARTMENT OF EDUCATIONAL RESEARCH
GOTHENBURG SCHOOL OF EDUCATION

Övre Husargatan 34
S-413 14 Gothenburg, Sweden

Research Bulletin No. 3. June 1970

ED057532

Risto Kääriäinen

# THE FACTOR STRUCTURE OF INTELLECTUAL ABILITIES AND SIGNAL SIGHT VOCABULARY LEARNING AT MODERATE AND SEVERE LEVELS OF PRELITERATE MENTAL RETARDATION

A test battery of items covering six hypothetical factors was gathered and given to 80 mentally retarded subjects. Four factors were extracted through factor analysis. These were called: Perceptual, Memory-quantitative, Psychomotor and Verbal-general. An analysis of the relationship between a learning variable (social sight learning) and intellectual factors showed that the perceptual factor had the highest positive correlation with the learning variable.

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY

Department of Educational Research
Gothenburg School of Education
June, 1970

Members of the Scandinavian research group on special education when this research was done were:

Professor Karl-Gustaf Stukát, Sweden
Fil mag Risto Kääriäinen, Finland
Fil kand Anna Lewerth, Sweden
Fil lic Gunnar Stangvik, Norway
Cand psych Niels Söndergård, Denmark

The general plan of this research was made by Risto Kääriäinen who is also responsible for data processing and report writing. The plan was, however, discussed and developed in the research group and the present report is a result of joint contributions from all group members.

CONTENTS


| | | |
|---|---|---|
| | PREFACE | |
| 1 | INTRODUCTION | 1 |
| 1.1 | The factor structure of intellectual abilities and signal-sight reading in moderately and severely mentally retarded | 1 |
| 1.2 | Earlier factor investigations on the preliterate level of mental retardation | 3 |
| 2 | HYPOTHESES | 7 |
| 2.1 | Factor hypotheses | 7 |
| 2.2 | The sample in the present investigation | 10 |
| 3 | RESULTS | 12 |
| 3.1 | The factor analysis of the test variables | 12 |
| 3.1.1 | The distributions and the intercorrelations of the test variables | 12 |
| 3.1.2 | The number of factors | 12 |
| 3.1.3 | The choice of the factorial solution | 13 |
| 3.1.4 | The choice of the rotational solution | 13 |
| 3.1.5 | The factor analytical results of the present study | 14 |
| 3.1.6 | A comparison of the present factor results with earlier factor studies | 15 |
| 3.1.7 | The second-order factor analysis | 18 |
| 3.1.8 | The correlations of the factor scores with the learning variable and with age | 18 |
| 3.2 | The generalized analysis of variance of the four factor scores between clinical and social groups | 19 |
| 3.3 | The multiple correlation analysis between learning- and test variables | 20 |
| 4 | DISCUSSION | 22 |
| 5 | SUMMARY | 25 |
| 6 | BIBLIOGRAPHY | 27 |
| 6.1 | References | 27 |
| 6.2 | Literature related to the subject of the present report | 29 |
| 7 | APPENDICES | A 1 |
| 7.1 | Tests used in the present study | A 1 |
| 7.2 | Tables | A 3 |

## PREFACE

The Scandinavian research group on special education began work in the autumn of 1966 at the Department of Educational Research of the Gothenburg School of Education.

The present investigation is part of the work of this group. The group, which is sponsored by the Nordic Culture Commission and the Nordic Culture Fund, has been staffed by research fellows from each of the Scandinavian countries and led by professor Karl-Gustaf Stukát in Gothenburg.

The main objective of the research of this group has been to develop a method for teaching trainable retardates on the preliterate level a social-sight vocabulary. To clarify the psychological aspects of this reading learning the present author has planned this investigation. The project and the field work together with the testing have been carried out in Sweden. The statistical analyses on electronic computers have been made at the Computing Center of the University of Jyväskylä in Finland.

I want to extend my thanks for the time of the scholarship and stimulating aid to my colleagues Anna Lewerth, Ann-Charlotte Carlberg, Niels Söndergård, Gunnar Stangvik and specially to professor K-G Stukát.

I will also express my gratitude to the Computing Center of the University of Jyväskylä and to professor V Heinonen who kindly made helpful criticisms and suggestions for the reflection problems in the factor analysis.

Risto Kääriäinen

# 1 INTRODUCTION

## 1.1 The factor structure of intellectual abilities and signal-sight reading in moderately and severely mentally retarded

To clarify various learning situations and aspects which influence the learning process it is possible to use factor analytical research of the structure of intellect, which describes individual differences in various intellectual abilities better than the one-dimensional classical IQ-research.

Signal-sight reading has been the topic of research in our Scandinavian group on special education, and it has been possible to use factor structure methods and to investigate with which possible intellectual factors this reading learning is related. The purpose of the present investigation has been to clarify which intellectual factors are needed and used in social-sight vocabulary learning. At the same time it has been possible to investigate the factor structure of intellectual abilities on this low intellectual level. In this field previous research, exept for Meyers et al (1962, 1964) does not exist.

Signal-sight vocabulary reading is not reading in the traditional sense, but rather correct understanding of and reaction to certain visual configurations, e g the words of the vocabulary. In terms of the programme vocabulary words are treated as signals. The vocabulary is exemplified by words like go, stop, exit, WC, and so on.

Social-sight vocabulary learning is an important part of social learning and it facilitates orientation in our complicated society. To teach this vocabulary to children on the preliterate level of mental retardation, who have special difficulties in our society, is a justifiable objective of research.

Previously this kind of vocabulary has been taught to mentally retarded children basically in either of two ways when using programmed instruction. One way is the Branching type (developed by Crowder) in which the learner is offered a series of alternative answers and only if he chooses the correct answer can he carry on. Items where he chooses wrongly are explained to facilitate insight. The second way, the Linear method (developed by Skinner), consists of a series of small steps in learning tasks, designed to ensure 95% correct responses. Programmed instruction is usually presented by machines, but can also be presented in book form.

Earlier studies of social-sight reading learning with programmed instruction have been reviewed in the report of our research group, Lewerth-Stangvik (1969). Reviewing this kind of research, Haskell (1966) reports an experimental use of a teaching machine (Prolemac 4) to investigate social-sight vocabulary learning on the adult level of mental retardation (IQ = 46-58). After 15 half-hour sessions of teaching these subjects learnt an average of 12 new words. Greene (1966) reviews several investigations on traditional reading learning with programmed instruction mostly dealing with mildly mentally retarded subjects.

It is a common experience made by people working with the mentally retarded that moderately and severely retarded people rarely learn to read by traditional methods and that they seldom fully use their reading and spelling ability. However, they can very well identify their own belongings or things that belong to their friends. The social-sight learning programme uses this perceptual ability by leading the subjects through a well organized set of visual discriminations to establish and strengthen the correct responses.

To map the words that were to constitute the programme material a questionnaire (Söndergård 1968) was sent to professional workes in the Scandinavian countries, i e to teachers, physicians, social workers, psychologists and so on, who were working in institutions for the care and education of moderately and severely retarded people.

The preliminary draft of the programme was in a picture-file form, each item consisting of one stimulus picture or word and three response pictures or word alternatives. A programme model was also developed for a TYLA teaching machine (Amcoff 1966) with the help of a large picture material prepared for each programmed word.

In a TYLA teaching machine there is one stimulus frame and three response frames. The machine registers all pressings on the response frames and the next item is produced 1) only after a correct response in the "learning" form of the machine 2) after any pressing in the "test" form. The picture or word in the stimulus frame should be associated with the right response frame. The distractor alternatives used in the response frames are pictures or words used in other social-sight words.

A signal-sight learning variable in this investigation is a sum of the responses to a programme of two signal-sight words (telefon, toalett). Each of the words has 38 items. So the minimum sum of pressings is 76.

The better the result of a person in this learning variable, the fewer pressings he or she will need to go through the whole programme.

A detailed report of the programmed instruction used in this learning variable and other methods used when our group was teaching signal-sight vocabulary has already previously been published by the research group (Lewerth and Stangvik 1969) and will therefore only very shortly be mentioned here.

## 1.2 Earlier factor investigations on preliterate levels of mental retardation

Dingman and Meyers (1966) and also Kebbon (1965) have recently reviewed earlier factorial studies using literate or preliterate mentally retarded subjects. A corresponding review is hardly necessary here, because no noticeable factorial studies have been published after these comprehensive reviews.

According to Dingman and Meyers (1966), factorial studies in this field can generally be classified in a number of groups. The first one consists of hypothesizing and factor structure seeking studies. To the second type belong the studies analysing existing test data, performed on files of test results secured over a period of time in schools, clinics, or research centers and obtained by standard instruments such as Binet, WISC etc. Such data are not compiled for the purpose of studying "structure" but for purposes for which, as a rule, the whole IQ or DQ has been of interest.

It is important to notice a difference between these first two types of studies. Little structure of an interpretable nature can be achieved without marker or reference tests in the factored matrix. In the hypothesizing and factor searching studies there are factorial tests covering the best-known factors at various maturity levels. For the younger ages there are not so many reference tests available, but some reference tests do exist and they will help interpretation if added to the matrix.

There is a great variety of factorial studies in which existing data have been factor analysed. To compare them with factor hypothesizing and seeking studies is not successful.

The third type of factorial studies utilizes factor findings and is mostly used to improve measurements. It results in a reduction in the variety of tests, or an increased factor purity in an individual test.

The fourth type of study is using factor scores which summarize the factor qualities of subjects. The scores can be used in various compari-

sons for diagnosis and in clinical or educational planning. The use of factor scores will move more rapidly with new computerized programmes to manage the considerable calculations required.

As a fifth type factor measures can also be used as controls in experiments. For example, different ability tests can be used to measure more precisely the abilities most closely related to the criterion.

As a sixth type factor batteries can be used in programme planning. If the battery is able to sample a wide spectrum of separate abilities for example in retarded children, it is possible to direct the planning of programs to the specific deficiencies indicated by the results of the battery.

Perhaps more than the above mentioned six types can be found to describe various possibilities to use factor studies, but none are possible without factor determinations, and therefore this work, which has just begun for children and for the retarded, is so important.

The reports of Dingman and Meyers and of Kebbon both point out that few factor hypothesizing studies with retarded subjects exist. Fewer still are the studies made with moderately or severely mentally retarded subjects. The most important and also the most comprehensive is the series of research works, which has been made in the Socio-Behavioral Study Center for Mental Retardation, Pacific State Hospital, Pomona, California. In this series there are among others Meyers, Orpet, Attwell & Dingman (1962) and Meyers et al (1964) in which the factor structure of intellectual abilities of normal and retarded children, 2, 4 and 6 of age, has been investigated.

Also Kebbon (1965) has a factorial study of the normal and the retarded structure of abilities. In this investigation the subjects were at mild or higher and literate levels. The two studies mentioned above represent the factor seeking and hypothesizing studies and are the only ones of this type in the field of mental retardation.

The factor tests which suit children or adults on a preliterate level are few or non existant. With the available reference tests new ones must be tried out. Three or more tests must be employed to represent a hypothesized ability factor. Hence a test battery can easily become too long and strenous for the subjects if too many factors are present in the battery.

On the other hand there are not many suitable factor seeking tests for various intellectual abilities. When the subjects are on a lower intellectual level, the items of a test must be easy enough and very motivating. Therefore, a considerable developmental period is needed with much experimenting, item analyses, and inspections of distributions. Since one must secure data on single subjects, who need two or more testing sessions, such a project will also be expensive and time consuming.

Because the present investigation and its hypotheses are based on earlier studies most of which have been mentioned above, it is necessary to review shortly the essential results of these studies.

The investigation of Meyers et al (1964) is large and involves various age levels. In this connection the results on the 6-year level of normal and retarded subjects are most interesting. At this level the following factor hypotheses are empirically verified.

The Psychomotor manual dexterity factor, which measures the quickness and dexterity in movements of the dominant hand guided by vision, is independent of the more pure mental abilities.

The Perceptual speed factor, present on the 6-year level in normal children, is characterized by the ability to solve tasks having in common the quick and sure identification, matching or differentiation of figural materials. The test items are not difficult discriminations, but the source of individual differences is the speed and accuracy of the working tempo. This hypothetical factor was not found independent on the 6-year level of retarded subjects, but together with the figural reasoning factor building a pure visual-perception factor. The speed component was not independent in the 6-year retarded child.

The Verbal factor involved tests measuring expressive and receptive vocabularies and a test of verbal fluency. This last mentioned test turned out to separate factorially from the other psycholinguistic tests at this 6-year maturity level in the normals and in the retarded. An independent and common semantic or linguistic factor is clearly evident at this age level. A potential fluency factor, Thurstone's ideational fluency, shows promise of future identification as a divergent linguistic factor.

The Figural reasonging factor measures the ability to deal with relationships among figural material and the power to resolve or understand these without time limit and employment of any language. This factor is independent in the 6-year normals, but in the 6-year retarded

it was combined with the perceptual-speed factor.

The rotation in the study of Meyers et al was done by analytical biquartimin and by procrustes methods. The procrustes is a factor conforming rotation for hypothetical factors in contrast with the factor verifying process in the biquartimin method. The second-order factor analysis of primary factors showed that the existence of correlations between the factors has not been a serious risk to the factor interpretations of structure which have been made.

The purpose of the study of Meyers et al was not to map out more precisely all possible abilities, or various verbal, psychomotor or memory functions. However, the series of studies of Meyers et al gives the best and also central information of factor structure at the preliterate level of intelligence in normals and in retardates.

In his investigation Kebbon also clarifies the problem if the mentally retarded have the same abilities as normals and whether their abilities are organized in the same way as in normals. He studied these problems with mildly retarded adults who should be at the literate level. Testing of subjects was made in small groups, not in the form of individual testing. The number of the hypothetical factors was seven, out of which four common factors could be extracted empirically. They were:

1. Verbal
2. Spatial-inductive
3. Numerical
4. Psychomotor

The factor structure was a little clearer at the lower levels of IQ than at higher levels, where a tendency to a hierarchic order was found, in which verbal-educational factors came first and a small psychomotor factor last. At the lower levels of IQ the psychomotor factor accounts for the greatest part of common-factor variance.

The rotation was made only into orthogonal structure with normal varimax criteria. The nature of the factors should assume correlations between them and therefore indicate oblique rotational solutions.

The numerical factor in mildly retarded subjects in the study of Kebbon led me to investigate this aspect in the present study with moderately and severely retarded children and to try to extract an elementary numerical factor at this intellectual level, at which no numerical tests of Kebbon's study could be used.

# 2 HYPOTHESES

## 2.1 Factor hypotheses

At the same time as an attempt has been made in the present study to clarify the role of the intellectual factors needed and used in signal-sight vocabulary learning, it has been possible to investigate empirically the factor structure on the preliterate intellectual level, on which there are only few earlier reports.

Six various hypothetical factors have been selected in the present study. They are not all supposed to be extracted empirically. In the selection of tests for our factors the aim has been to take, for every factor, available reference or marker tests, which have been present in the earlier factor studies and showed their factor qualifications there. With new tests for every factor it is possible to examine their factor qualifications. A criterion of a reported reliability of .60 was used as the lowest limit for each test. If possible, the reliabilities must be based on data from retarded subjects. Some of the tests are paper-pencil, some performance type of tests. The latter type compared with the paper-pencil type has been hypothesized to be better with moderately and severely retarded subjects. The hypothetical factors are:

Psychomotor
Perceptual speed
Verbal
Spatial reasoning
Memory
Quantitative-numerical

The tests used in the psychomotor factor:

1. Bead Stringing
2. Line Drawing
3. Peg Board

The first two tests in this factor have been used in the study of Meyers et al (1964). Test 1 uses the same material as the S-B scale, cubic beads. Test 2 is in the PMA series of Thurstone & Thurstone, in the part of K-1. Test 3 has been chosen because it is motivating for the retarded subjects. It is a modification of the Dexterity Test of Stromberg,

without colour discriminations. Tests 1 and 3 are performance-type, test 2 is of the paper-pencil type. All the tests used in this investigation are described in detail in the Appendix.

The tests used in the perceptual speed factor:

4. Identical Pictures
5. Pacific Perceptual Speed
6. Form Board
7. Block Design modification

The first two tests have been used in the study of Meyers et al. Test 4 is in the K-1 part of the PMA-series. Test 5 is developed in the study of Meyers et al. The present author has developed test 6. It is a form-board which has been used clinically for 10 years with retarded subjects and it fulfils the criterion of reliability. The test is also motivating for moderately and severely retarded subjects. Test 7 is in the WPPSI series and a modification of the original test. This modification was made to give enough easy items to the scale. Tests 4 and 5 are of the paper-pencil type, tests 6 and 7 are of the performance-type.

The tests used in the verbal factor:

8. Peabody Picture Vocabulary Test (Form B)
9. Van Alstyne modification (expressive part)
10. Van Alstyne (receptive part)
11. Monroe Language Classification

The picture material in verbal vocabulary tests is easily influenced by cultural background. Therefore, the tests for the hypothesized verbal factor are selected from the available vocabularies best suited for the purpose of the present study. Test 8 is an original version without modification. Test 9 is a modification of the Van Alstyne test. The picture material is the same as in the original receptive part and therefore it has been possible to compare differences between the modified expressive and receptive parts. Test 10 is the original Van Alstyne. Test 11 has earlier been used in the study of Meyers et al and represents verbal fluency, which differs from the general verbal factor at this maturity level.

The tests used in the spatial-reasoning factor:

12. Raven (colored, set A + Ab)
13. Pacific Pattern Copying

In the previous studies this factor has not been an independent one on the 6-year level in retarded subjects. This aspect has again been investigated here. Both tests in this hypothesized factor have been used in the study of Meyers et al. Test 13 is of the paper-pencil type. Test 12 is not classifiable in this respect.

The tests used in the memory factor:

14. Auditory Memory. Auditory-Vocal Sequencing Test. (ITPA)
15. Visual Memory. Visual-Motor Sequencing Test (ITPA)

In learning situations memory has its own and interesting part. In testing the hypothetic memory factor it has not been possible to use long-time memory tasks, which would be well justified, in connection with the investigation of signal-sight reading. Only short-time memory (periods of less than a minute) tasks are used to test the hypothetical factor. Ellis (1963) was the first to point out that the short-time memory in the mentally retarded was worse than in normals. Hermelin and O'Connor (1964) stated a faster decay rate of immediate memory in subnormals than in normals. Scott & Scott (1968) have reviewed the research of this problem and the difficulties in comparing the short-time memory results between normal and retarded subjects. Ellis and Anders (1968) have again returned to this problem and have not been able to confirm definitely the earlier point of view.

The tests used in the quantitative-numerical factor:

16. Arithmetic (WPPSI)
17. Q-test (PMA, K-1)

One of Thurstone's PMA-factors is N, number facility, which is a measure of the ability to handle simple quantitative problems rapidly and accurately and to understand and recognize quantitative differences. The scores in test 17 are based on a pictorial material and requires no reading. The test from the K-1 series is for kindergarten pupils. Thurstone has stated the number factor for normal children between 5 and 6 years of age, Kebbon for adult mildly retarded subjects. In this investigation there is an attempt to extract an elementary quantitative number factor on the moderate and severe levels in the mentally retarded. Test 16 is taken from the WPPSI.

Some of the tests used for various hypothetical factors needed modifying because the subjects were moderately and severely retarded. Most modifications were made to get enough easy items to secure better

distributions for some variables such as tests 7 and 13. The scoring of the tests was also revised whenever necessary for the same reason.

In the construction of the present test battery there has been a tendency to stress the perceptual speed factor, because it was assumed to have a central part in the battery. The number of tests in the battery is seventeen and therefore it is time consuming and strenuous for retarded subjects. The individual testing session was divided into two parts, each of which took 1 - 1.5 hours per subject. The author first gave the performance part of the battery (tests 1, 3, 6, 7, 12, 14, 15) to all subjects and after that the verbal part was given by the psychologists Ann Charlotte Carlberg and Anna Lewerth.

The weakest of the hypothetical factors were the two last ones, memory and quantitative-numerical. For these there were not enough available and ready-made tests and the battery was growing too large and therefore these factors remained most hypothetical. A detailed description of the test battery and a table of the reliability coefficients of the tests are given in the Appendix.

The objectives of this investigation can be stated shortly in the following way:

1. To clarify the roles of the various intellectual abilities in signal-sight vocabulary learning on moderate and severe levels of mental retardation.

2. At the same time to investigate the factor structure on the preliterate level on which only few earlier reports of factor studies are available.

3. Further to construct and evaluate new tests and their factor qualifications together with earlier reference factorial tests.

4. To investigate with the help of factor scores and with multivariate statistical analyses the possible differences in factor structure between various social and clinical groups.

## 2.2 The sample in the present investigation

The aim of the present investigation is to try to clarify the signal-sight reading on the preliterate level with moderately and severely mentally retarded subjects (IQ = 25-55). The chronological age of the male and female subjects was allowed to vary between 10 and 25 (years).

Two large Swedish institutions with care for the mentally retarded, Stretered in Gothenburg and Johannesberg in Mariestad, were searched in order to find subjects who filled these criteria with the aid of the psychologists in these institutions.

The representativeness of the sample was not evaluated, because it was difficult to collect a sufficient number of subjects fulfilling the requirements in the criteria used. In the sample there are 80 subjects, 41 male and 39 female. The mean age was 208.4 months (17 years 4 months). 49 lived in institutions and 31 in open care. Down´s syndrom (mongolism) cases were 24, non-mongols 56. In addition to the group of mongoloids, there was no other known group of clinical cases. Only one case of paraplegia with good motor hand coordination and one case of hemiplegia were found in the sample.

The main difficulty in sampling refers to the control of the variability of chronological and mental age, which should be as reduced as possible. This aspect is already known in the previous investigation (Dingman and Meyers 1966). The clarity of factor structure is most probably secured if the sample is homogenous in these respects. As an example of the difficulty Dingman and Meyers mention an investigation of abilities at mental age four in retardates, where only 30 subjects within a few months of that mental age could be drawn from a total institutional number of 3000 cases.

The test battery is also a cause of subject loss with its 17 tests of semantic, psychomotor, memory and visual-perceptive abilities. All these abilities eliminate certain types of mentally retarded people. Therefore those who are visually limited, patients with hearing loss, central or peripheral, aphasic or autistic, reactive or seriously cerebral palsied patients and so on, not testable with all tests in the battery, are not included in the sample. Many of the subjects in this group show the most striking and interesting features in their factor profiles.

The selection of subjects in the institutions was made according to the IQ and other criteria previously obtained with the combination of the Terman-Merrill and Raven scales. The traditional reading ability was tested before presenting the test battery with the following words requiring reading or spelling ability of the subject: FARA, APOTEK, UTGÅNG, DAMER, HERRAR, TELEFON (Danger, Exit, Ladies, Gentlemen, Telephone).

# 3 RESULTS

## 3.1 The factor analysis of the test variables

### 3.1.1 The distributions and the intercorrelations of the test variables

The means and standard deviations of the test variables, of age, of the four factor scores and of the learning variable are given in Table 1. The normality and the symmetry of the distributions have been inspected only visually. There is no notable skewness in the distributions. The intercorrelations of the test variables are product moment correlations determined from the raw scores and are given in Table 2.

The statistical analyses of the empirical results were made at the Computing Center of the University of Jyväskylä in Finland except for the principal components analysis which was made at the Computing Center of the University of Gothenburg.

### 3.1.2 The number of factors

In order to decide how many common factors that are necessary and also reliable and meaningful for the explanation of the correlations among the variables (Harman 1967, p 198), a principal components analysis was made with the unities in the diagonal. The eigenvalues in this analysis are given in Table 3. As a combined criterion of the correct number of common factors can be used:

1. Eigenvalues greater than one (lambda = 1).
2. The cumulative percentage of the factors from the total variance.
3. At least one of the factor-loadings must be greater than four times its standard error.
4. The interpretability of the factors.

Cattell has developed a method called the scree-test (1966) for the determination of the factor number. This test involves graphing the latent roots of the correlation matrix and inspecting the shape of the graph. This curve is presented in Table 4. According to this criterion the correct number of factors is four. After the consideration of the combined criteria, this number has been decided as a final solution. A check (Harman 1967, p 153) on the adequacy of the present four-factor

solution is the extent to which the sum of the contributions of factors agrees with the original total communality. The sum of the first four eigenvalues is 10.8106 and the original total communality is 10.803. Since the SMC´s are lower bounds of the communalities the slight difference between the sums is tolerated.

### 3.1.3 The choice of the factorial solution

There was an attempt to use several and the newest factorial solutions, but the computer programs for them were not available in Scandinavia. Therefore the principal factor solution (Harman, 1967, p 135) with SMC-communalities was the only method used here. It was made with IBM 1130.

### 3.1.4 The choice of the rotational solution

On the basis of findings in earlier factor studies (Meyers et al 1962 and 1964) the orthogonal solutions were considered inappropriate. Hence rotations into oblique solutions were the main requirements in this study. Because the analytical methods with electronic computers have put aside other more or less subjective rotations an appropriate analytical solution was tried to be found. But there were no possibilities for all computer programmes already made elsewhere.

A practical and available method for oblique and analytical rotation is the Promax-solution (Hendricksen and White 1964), in which an orthogonal solution is used first, and then an ideal transformation into an oblique solution is made. As an orthogonal criterion Kaiser Varimax is used. An optimal value for k, which is analogous to the problem of deciding on a value for the weighting parameter gamma in oblimin solution, is K= 4. The Promax-solution has given exactly the same results as the binormamin analytical and oblimin method developed by Kaiser and Dickman (Harman 1967, p 326). The eigenvalues, the principal factor matrix and the promax oblique rotation matrix with the final communalities are presented in Table 5. The promax rotation was also made for 3-, 5-, and 6-factor solutions. These possibilities are shown in Table 7.

All appropriate and desired factorial and rotational methods were not available and the application of two or more techniques of factor extraction and rotation, as Glass and Taylor (1966) have suggested, was not possible. After all the methods used in the present study give a

good and adequate basis for the factor interpretation selected.

3.1.5 The factor analytical results of the present study

Studied empirically the perceptual speed factor changed its nature and joined in the spatial reasoning factor on this maturity level. The speed component is not present, because the tests in the reasoning factor were not timed, but still have high loadings in the common visual perception factor, which can also be called spatial-inductive according to Kebbon. On this level the speed factor is not the same as for normal subjects on the same maturity level. The fact that the speed factor does not exist in this group of mentally retarded subjects may be a characteristic feature of the preliterate level and of difficulties in traditional reading. The highest factor-loadings in this visual perceptual factor are:

| | | |
|---|---|---|
| Identical Pictures | test 4 | loading .84 |
| Block Design | " 7 | " .80 |
| Pacific Pattern Copying | " 13 | " .80 |
| Visual Memory | " 15 | " .71 |

A second factor was a combination of auditive memory test 14 and quantitative-numerical tests 16 and 17. In the same factor was also test 11 of verbal fluency in the four-factor solution. In this memory-quantitative factor the highest loadings were:

| | | |
|---|---|---|
| Auditive Memory | test 14 | loading .87 |
| Arithmetic | " 16 | " .79 |
| Q-test | " 17 | " .67 |

As a third factor a psychomotor factor was clearly extracted with the highest loadings:

| | | |
|---|---|---|
| Bead Stringin | test 1 | loading .86 |
| Pegg Board | " 3 | " .82 |
| Line Drawing | " 2 | " .53 |

As a fourth factor a verbal factor was extracted with the highest loadings:

| | | |
|---|---|---|
| Peabody PVT | test 8 | loading .82 |
| Van Alstyne (receptive) | " 10 | " .75 |
| Van Alstyne (expressive) | " 9 | " .62 |

The predicted and extracted factor contents of each of the tests is listed below:

| Test | Main factor contents: Hypothesized | Extracted |
|---|---|---|
| 1. Beads | Psychomotor | Psychomotor |
| 2. Lines | " | " |
| 3. Peggs | " | " |
| 4. Ident. Pictures | Perceptual speed | Perceptual |
| 5. PPS | " | " |
| 6. Forms | " | " |
| 7. Blocks | " | " |
| 8. PPVT | Verbal | Verbal |
| 9. Expr VA | " | " |
| 10. Recept VA | " | " |
| 11. Monroe | " | Memory-quantitative |
| 12. Raven | Spatial-reasoning | Perceptual |
| 13. PPC | " | " |
| 14. Auditive Memory | Memory | Memory-quantitative |
| 15. Visual Memory | " | Perceptual |
| 16. Arithmetic | Quantitative | Memory-quantitative |
| 17. Q-test | " | " |

3.1.6 A comparison of the present factor results with earlier factor studies

The present factor results are nearly identical in many respects with the study of Meyers et al (1962, 1964) on the same maturity level. The present factors are also the same as those which Kebbon (1965) found on the mild and literate levels in the mentally retarded. The comparison with the study of Meyers et al can be made more easily, because the tests used are more similar and the intellectual level is the same. In both studies the hypotheses of verbal and psychomotor factors were clearly verified. Also, in both studies verbal fluency could be separated from the other verbal tests at this maturity level. The hypothesis of the perceptual speed was verified in the same way in both studies. This factor joined in the spatial reasoning factor. The speed component was not the same as on the corresponding maturity level in the normals.

Because the present investigation used more tests than the study of Meyers et al, a little more could be extracted, namely a combined

memory-quantitative factor. Each of the components in this factor, the immediate memory, numerical and verbal fluency components, need further research on this maturity level. The 5-factor solution in Table 7 shows that verbal fluency is now an independent factor.

Of the hypothesized factors, immediate memory and quantitative-numerical, the last one was not in the matrix of Meyers et al. The elementary form of this numerical factor is extracted in the present study, but combined with the immediate memory test. This combination is present in the 5- and 6-factor solutions, too. The immediate memory factor has been extracted in a very probable form in the study of Meyers et al (1962).

Loeffler (1965) has made a partial replication and extension of Meyers' study. The purpose of Loeffler's study was to extend the test battery to clarify possible memory and verbal fluency factors and possible further separation of abilities. Because IQ and CA data are not given, it is possible that the subjects used have been on higher levels than severe or moderate. With the battery of 32 tests and 100 mentally retarded children with mean MA of 6-7, Loeffler could extract six factors:

Figural Identification
Verbal (comprehension)
Verbal (fluency)
Memory (visual)
Memory (auditory)
Figural Reasoning

The same memory tests as in the present study (tests 14 and 15) were also in the matrix of Loeffler and were loaded with the corresponding memory factors, too. Verbal fluency and figural reasoning were also independent factors. As the data are not published, it is impossible to explain these results. Some comments can be made, however. The factor extraction procedure in the study of Loeffler is made with principal components analysis, not with common-factor solution and thus differs from the other studies mentioned here. An other source of difference may be the subjects in the study. In spite of its limitations the Loeffler study may show the direction of factor findings when the spectrum of abilities is expanded according to the model of Guilford (1967) and may represent the structure of abilities of children on mild levels of retardation.

The common verbal, psychomotor and perceptual factors have the same nature in the present study as they have had in the previous studies. The memory-quantitative factor with a loading of fluency or a divergent production component is extracted in very probable form on moderate and severe levels of mental retardation. All these components need further research on this maturity level.

A comparison between the empirical factors of the present study and the model of the structure of intellect (SI) of Guilford (1967), shows that factor I, perceptual, is the same as EFU (evaluation of figural units) in the SI model. The tests for the SI factor CFT (cognition of figural transformations), CFR (cognition of figural relations) and NFR (convergent production of figural relations) in the hypothetical spatial-reasoning factor of the present study are on this maturity level on the same, EFU - factor.

The traditional number factor has previously been put in the NSI-cell (convergent production of symbolic implications) of the SI, but more recent experience has revealed the memorial character of many number tests and the role of MSI (memory for symbolic implications) factor of the SI in the traditional number factor (Guilford 1967, p 132). The recent analyses mentioned by Guilford (1967, p 118, 134) have also thrown light upon the memory-span and numerical-operations tests which are complex and not factorially strong and have substantial specific components.

Factor II, memory-quantitative, in the present study gives the same result of the nature of the number factor as the earlier studies of Davis and de Mille (Guilford 1967, p 133); memory and elementary quantitative tests are present in the same factor.

The memory component of factor II represents MSU (auditory memory for symbolic units) and the quantitative component of the same factor represents MSI (memory for symbolic implications) and NSI (convergent production of symbolic implications) in the SI model.

Factor III, psychomotor, is independent of the more purely intellectual abilities of the SI model.

Factor IV, common verbal, has two factors of the SI model: CMU (cognition of semantic units) and DMU (divergent production of semantic units).

3.1.7 The second-order factor analysis

In Table 6 the intercorrelations of the primary factors are given. They show positive correlations between the factors. All factor ocrrelations are over .50. The correlations between factor I and II, II and IV, and I and III are over .60.

The second-order factor analysis was made on the intercorrelation matrix of the primary factors to investigate the selected correlative and oblique factor solution. The independent nature of the first-order factors can be investigated with this factor analysis, which shows the power of the factors to resist collapsing into a simple structure in spite of the factor correlations.

First the principal components analysis with unities in diagonals was made. Then for the factor matrix a Varimax rotation was made. The results in Table 6 confirm the selected factor structure interpretation. Each of the first-order factorsloads strongly on its exclusive second-order factor, loadings on the other second-order factors being insignificant. The intercorrelation matrix of the second-order factor analysis of the primary factors and the principal components factor and Varimax rotation matrices are presented in Table 6.

3.1.8 The correlations of the factor scores with the learning variable and with age

The factor scores are computed with the complete estimation method (Harman 1967, p 350). The correlations and the partial correlations ($r_p$) between the factor scores and the learning variable are the following:

Factor I (perc)/learning $r = .472$ $p < .01$ $r_p = .462$ $p < .001$
Factor II (m-q)/learning $r = .393$ $p < .01$ $r_p = .369$ $p < .01$
Factor III (psych)/learning $r = .254$ $p < .10$ $r_p = .216$ $p < .50$
Factor IV (verb)/learning $r = .328$ $p < .02$ $r_p = .285$ $p < .05$

The partial correlations were also computed to find the correlations between the learning variable and the factor scores quite apart from the influence of age. After this correction only the partial correlation between factor III (psychomotor) and the learning variable is not significant. A good learning result is secured especially with factors I, II and IV.

The correlations between the factor scores and age are:

| | | | |
|---|---|---|---|
| Factor I | (perc)/age | r= .107 | p $<$ .50 |
| Factor II | (m-q )/age | r= .165 | p $<$ .50 |
| Factor III | (psych)/age | r= .204 | p $<$ .10 |
| Factor IV | (verb )/age | r= .246 | p $<$ .05 |

The two last correlations are significant. With increased age the psychomotor and the verbal abilities correlations go up, but only slightly.

The correlations of age and the learning variable with all variables investigated in the present study are shown in Table 8.

## 3.2 The generalized analysis of variance of the factor scores between clinical and social groups

The generalized analysis of variance tests the significance of differences between groups located in a multidimensional criterion space (Cooley-Lohnes 1962, p 60). In multivariate analysis the dispersion of a sample group is the matrix of variances and covariances of the group. The null hypothesis of the test of homogeneity of dispersions, H 1, asserts that the groups have equal dispersions. Significance tests in a multivariate analysis need the help of electronic computers, because matrix algebra poses laborious arithmetic problems.

The test of H 2 asserts the equality of group centroids. It is insensitive to moderate departures from homogeneity of dispersions. The H 1 and H 1 programmes were run with IBM 360/30. The results in a shortened form are given in Tables 9-11. In Table 12 the means of each factor in various groups in the form of a graph are presented.

The differences in factor profiles (in a four-dimensional criterion space) between male and female in Table 9 are so great, that the null hypothesis was rejected in both H 1 and H 2 tests (H 1:p $\leq$ .10, H 2: p $\leq$ .025).

The second group-analysis was made between institutionalized and open care patients (Table 10). Only H 1 gave a significant difference (p$<$.01). In the test of H 2 the null hypothesis was not rejected. It is not sensitive to small departures from homogeneity of dispersions.

The third group analysis was made between mongoloid and non-mongoloid groups (Table 11). The test of H 1 showed highly significant difference (p$<$.005) and H 2 was also highly significant (p$<$.005). Especially

in this clinical grouping the differences in the factor scores or profiles were clearly demonstrated. Mongoloid and non-mongoloid retarded subjects on about the same level differs in their factor profiles in the direction seen in Table 12. The scores in all factors are higher in non-mongoloid than in mongoloid retarded people. The differences between these groups are greatest in factors III (psychomotor) and II (memory-quantitative).

## 3.3 The multiple correlation analysis between the learning and test variables

The multiple correlational analysis was made with the test variables used as predictor variables and the learning variable as a single criterion measure. With this analysis it was possible to see which tests have the best predictive value for the criterion variable and also to compute a regression equation with beta weights for each predictor variable and regression scores for new subjects as well.

The regression analysis with regression coefficients for each test are shown in Table 13. The multiple correlation coefficient R = .641 is not significant which is brought out also in the significance test (Cooley-Lohnes, 1962, p 34).

$$F^{m-1}_{N-m-2} = \frac{R^2 (N-m-2)}{(-R^2) \cdot (m-1)} = \frac{.411 \cdot 33}{.589 \cdot 17} = 1.354 \quad \text{N S}$$

$R^2$ = .411 means that 41 per cent of the variance in the learning variable is predictable from this test battery. As to the correlation coefficients in Table 13 it must be remembered that they correlate positively with low learning scores and negatively with high learning scores.

A selective regression analysis (Efroymson 1967, pp 191-203) was also carried out in which a computerized programme removes or enters variables according to the selected F-level. This F-level is a ratio between the difference of the sums of squares of the last and the next to the last phase and the mean of the squared errors of the last phase. The F-levels used to remove or to enter the variables were .50 and .30 respectively. This programme gives the multiple R = .613 ($B^2$ = .376) with 8 variables. The last phase of this analysis is seen in Table 4. With the 8 selected variables nearly the same multiple correlation was obtained as with all 17 variables and now the R is significant ($p \leq .01$).

The significance of the difference between $R_1$ and $R_2$ can be tested with the formula (McNemar 1955, p 279):

$$F = \frac{(R_1^2 - R_2^2) \,/\, (m_1 - m_2)}{(1 - R_1^2) \,/\, (N - m_1 - 1)} \qquad \text{with } n_1 = m_1 - m_2 \qquad n_2 = N - m_1 - 1$$

$m_1$ = the number of all variables

$m_2$ = the number of the variables selected from among the $m_1$ variables

$$F = \frac{.035 \,/\, 9}{.59 \,/\, 35} = 0.237 \text{ N S}$$

The small gain in using all variables does not carry statistical significance.

The regression equations for the standard scores of all and the selected variables are in Table 15. The multiple correlational analysis was computed with IBM 360/30 and the stepwise linear regression analysis with IBM 1130.

In the regression analysis only 53 subjects of the original sample of 80 are included, because one of the subjects was seriously ill, six could not use the teaching machine and nine were able to "read" the signal-sight words used. This last-mentioned group shows that there are self learned abilities for signal-sight vocabulary, without any formal training on the preliterate moderate and severe levels of retardation.

# 4 DISCUSSION

In the present study the principal aim has been both to use factorial design as control in a reading learning experiment and also to use a factor hypothesizing and seeking type of study on the moderate and severe levels of mental retardation. Factor scores are also used when various clinical or social groups are compared.

In a control type of factorial design the criterion has been the learning variable and different ability tests are used in an attempt to control the abilities most closely related to the criterion variable. Most of the types of factorial designs mentioned in chapter 1.2 are used in the present investigation, namely:

1. the factor structure hypothesizing and seeking-type
2. the utilizing factor findings-type
3. the using factor scores-type
4. as controls in experiment-type
5. the programme planning-type

When considering the sampling possibilities in studies made with the mentally retarded, it is clear that these possibilities can hardly be used, because the practical possibilities for sampling are so limited. The only solution is to collect suitable subjects in large institutions for residential and open care patients.

The most important limitation for the present sample has been the mental age and chronological age variability of the subjects. A radical reduction of this variablility has not been possible without loss of subjects.

The number of the tests in the battery of this study could not be much greater without making the task too heavy and strenuous for the subjects. Another set of tests in the battery would have given another ability combination. Some tests selected in the battery and having a high difficulty level have been modified to contain enough easy items to secure better distributions.

A comparison between the paper- and pencil and the performance types of tests shows that these types are equally well represented in the highest loadings of the extracted factors in which they have been represented. Also the paper- and pencil type of tests is useful

on this level of maturity if the motivation to use paper and pencil is great enough. On the contrary they also have some limitations as seen with the PPC-test (no 13), where the number of items was too small and thus difficult. The size was altered for the first and easiest items.

All the new tests in the battery have fulfilled the expectations set for them. With reference tests it has been possible to test their factor qualifications. As seen in the table of factor loadings (Table 5), all new tests have had significant loadings in their own factors. The form board test (no 6) has a speed component investigated earlier with this test (Kääriäinen) and when this speed component is not present on this maturity level, the factor loading has not been high. Other speeded tests in the present battery also have the same tendency.

The factor results obtained here might be altered when using other factorial or rotational methods, but have given the same structure of abilities as secured before in other factorial studies on the same level of maturity. The factorial and rotational methods can vary according to possibilities for suitable and available programmes or considerations used in factorial design, but they also show a certain degree of agreement between them, as seen in various factorial studies compared here.

Factor I, perceptual, has the greatest contribution to the total communality of the variables and is a combination of two hypothesized factors without the speed component. The correlation of this factor I with the learning variable has been the greatest of all factor correlations with this criterion variable, thus confirming the hypothesis of the central role of this factor in the present study.

Factor II has three components needing further evidence: immediate memory, quantitative-numerical and fluency of divergent production. Perceptual, psychomotor and common verbal factors have been extracted earlier and have the same nature in all adequate studies.

The generalized multivariate analysis of variance of the factor scores between clinical and social groups was made more effectively than in the univariate analysis. The method used here is a good tool in this kind of analysis when comparing the factor scores or profiles between various groups. The highly significant difference in the factor profiles between mongoloid and non-mongoloid retarded people

on moderate and severe levels has been stated here for the first time with this kind of multivariate analysis, which tests the significance of differences among groups located in a multidimensional criterion space.

The differences in the factor profiles between the male and female subjects in the present study possibly reflect a sample bias or a selective tendency of services for moderately retarded males: moderately retarded females are more than male ones reared at their homes.

The multiple regression analysis between the learning variable and all test variables gave a coefficient which was not significant. The selective regression analysis with 8 test variables gave a significant multiple correlation (R = .613) with the criterion. The regression equations were determined for further purposes in the studies of our research group. The regression analysis shows that a considerable part (59%) of the variance of the present learning variable is not predictable with the test battery used and remains unexplained in such a learning situation as the one used here.

# 5 SUMMARY

In order to study the signal-sight reading learning and the factor structure on preliterate moderate and severe levels of mental retardation (IQ = 25-55) a test battery of six hypothetical factors was constructed.

The sample in the present study was selected from mentally retarded patients in residential and open care of two large Swedish institutions and consists of 80 male and female subjects on preliterate moderate and severe levels of mental retardation.

The principal factor solution with SMC-communalities, and the promax analytical oblique rotation were used in the factor analysis of the correlation matrix of the test variables. The factor scores were computed with the complete estimation method.

Of the hypothetical factors the following ones were secured empirically: perceptual, memory-quantitative, , psychomotor and common verbal factors. The results were essentially the same as those that Meyers et al (1962, 1964) have obtained on the same maturity level and also apparently identical with the factors secured by Kebbon (1965) on adult mild and literate levels of mental retardation.

In comparing the factor scores in multivariate analysis between clinical and social groups, the generalized analysis of variance showed highly significant differences in the factor profiles between mongoloid and non-mongoloid retarded. A significant difference was also found in the factor profiles between male and female subjects.

The multiple correlation between the eight selected tests and the learning variable was significant and 41 per cent of the variance in the learning variable is predictable from the test battery used.

With signal-sight reading learning factor I, perceptual, has the highest positive correlation. In factor I the speed component is not present. The next highest correlations with the learning variable are found in factor II, memory-quantitative and factor IV, verbal.

Some new tests and their factor qualifications are tested in the present battery together with earlier reference tests. All these had significant loadings in their factors and so fulfilled the expectations set for them.

The present investigation shows the common observation in all previous factorial studies, also here reviewed, that the one-dimensional IQ-description of intelligence is not adequate to characterize the intellectual ability structure not even on preliterate moderate and severe levels in the mentally retarded. It is possible even on this level to secure a differentiated factor structure. The task of future studies is to extend the further separation of abilities and to develop adequate factorial tests for this maturity level.

# 6. BIBLIOGRAPHY

## 6.1 References


Amcoff, S

1966 Självinstruerande metoder i dövundervisningen. In Stukát, K-G & Engström, R (Eds): Samnordisk specialpedagogisk forskning. Rapporter från Pedagogiska institutionen vid Lärarhögskolan i Göteborg, no 2, 46-51.

Cattell, B

1966 The Scree Test for the number of factors. Mulitvariate Behavioral Research, vol 1 (April), 245-276.

Cooley, W W - Lohnes, P R

1962 Multivariate procedures for the behavioral sciences. John Wiley & Sons Inc, New York.

Dingman, H F - Meyers, C E

1966 The structure of intellect in the mental retardate. In Ellis, N R (Ed): International review of research in mental retardation, vol 2. Academic Press, New York.

Efroymson, M A

1967 Multiple linear regression. In Ralston, A & Wilf, H S (Eds): Mathematical methods for digital computers, vol 1, 191-203. John Wiley & Sons Inc, New York.

Ellis, N R

1963 The stimulus trace and behavioral inadequacy. In Ellis, N R (Ed): Handbook of mental deficiency. McGraw-Hill, New York.

Ellis, N R - Anders, T R

1968 Short term memory in the mental retardate. American Journal of Mental Deficiency, vol 72, no 6, 931-936.

Glass, G V - Taylor, P A

1966 Factor analytic methodology. Review of Educational Research, vol 36, 566-587.

Greene, M

1966 Programmed instruction techniques for the mentally retarded. In Ellis, N R (Ed): International review of research in mental retardation, vol 2. Academic Press, New York.

Guilford, J P

1967 The nature of human intelligence. McGraw-Hill, New York.

Harman, H H

1967 Modern factor analysis. University of Chicago Press, Chicago.

Haskell, S H

1966 Programmed instruction and the mentally retarded. In The application of research to the education and training of the severely subnormal child. A monograph supplement to the Journal of Mental Subnormality, April 1966, 15-24.

Hendricksen, A E - White, P O

1964 Promax: A quick method for rotation to oblique simple structure. The British Journal of Statistical Psychology, vol 17 (part 1), 65-70.

Hermelin, B - O'Connor, N

1964 Short term memory in normal and subnormal children. American Journal of Mental Deficiency, vol 69, no 1, 121-125.

Kebbon, L

1965 The structure of abilities at lower levels of intelligence. A factor-analytical study. AB Broberg & Söner, Stockholm.

Kääriäinen, R

A factor analysis of a test battery with subjects of normal 7-year-old children. Unpublished manuscript.

Lewerth, A - Stangvik, G

1969 Läsning av socialt viktiga ord. Ett försök med programmerad undervisning för utvecklingsstörda. Samnordiska projektet i specialpedagogik 2. Rapporter från Pedagogiska institutionen vid Lärarhögskolan i Göteborg, no 9.

Loeffler, F J

1965 An extension and partial replication of Meyers' et al's primary abilities at mental age six. Paper presented at the biennial meeting of the Society for Research in Child Development, Berkeley, California, April 1963. Summarized in Bateman, B: The Illinois Test of Psycholinguistic Abilities in current research. Institute for Research on exceptional children, University of Illinois, Urbana, Illinois.

McNemar, Q

1955 Psychological Statistics. John Wiley & Sons Inc, New York.

Meyers, C E - Orpet, R E - Attwell, A A - Dingman, H F

1962 Primary abilities at mental age six. Monographs of the Society for Research in Child Development, Ser no 82, vol 27, no 1. The Antioch Press, Yellow Springs, Ohio.

Meyers, C E - Dingman, H F - Orpet,R E - Sitkei, E G - Watts, C A

1964 Four ability-factor hypotheses at three preliterate levels in normal and retarded children. Monographs of the Society for Research in Child Development, Ser no 96, vol 29, no 5. The Antioch Press, Yellow Springs, Ohio.

Scott, K G - Scott, M S

1968 Research and theory in short-time memory. In Ellis, N R (Ed): International review of research in mental retardation, vol 3. Academic Press, New York.

Söndergård, N E

1968 Enquête vedrörende socialt vigtige signalord og læsemetoder for psykisk udviklingshæmmede elever i IQ-området 30-55. In Stangvik, G (Ed): Förberedande studier rörande läsning av socialt viktiga ord i träningsskolan. Samnordiska projektet i specialpedagogik 1. Rapporter från Pedagogiska institutionen vid Lärarhögskolan i Göteborg, no 8.

## 6.2 Literature related to the subject of the present report

Baehr, M E

1963 A comparison of graphic and analytic solutions for both oblique and orthogonal simple structures for factors of employee morale. Psychometrika, vol 28, no 2, 199-209.

Bashaw, W L - Ayers, J B

1967 An evaluation of the norms and reliability of the PPVT for pre-school subjects. Educational and Psychological Measurement, vol 27, 1069-1075.

Bateman, B

1965 The Illinois Test of Psycholinguistic Abilities in current research. Institute for Research on Exceptional Children, University of Illinois, Urbana, Illinois.

Buros, O K (Ed)

1965 The Sixth Mental Measurements Yearbook. Gryphon Press, Highland Park, New Jersey.

Carroll, J B

1957 Biquartimin criterion for rotation to oblique simple structure in factor analysis. Science, vol 126, 1114-1115.

Cattell, R B

1957 A universal index for psychological factors. Psychologia, vol 1, 74-85.

1965 Factor analysis: An introduction to essentials. I. The purpose and underlying models. Biometrics, vol 21, 190-215.

Clausen, J

1966 Ability structure and subgroups in mental retardation. Spartan Books, New York.

Cooley, W W - Jones, K J

1964 Computer systems for multivariate statistical analysis. Educational and Psychological Measurement, vol 24, no 3, 645-653.

Edgren, J - de la Chapelle, A - Kääriäinen, R

1966 Cytogenetic study of seventy-three patients with Down's Syndrome. Journal of Mental Dificiency Research, vol 10, 47-62.

Eyman, R K - Dingman, H F - Meyers, C E

1962 Comparison of some computer techniques for factor analytic rotation. Educational and Psychological Measurement, vol 22, no 1.

Eysenck, H J

1967 Intelligence assessment. A theoretical and experimental approach. British Journal of Educational Psychology, vol 37, 81-98.

Harris, C W

1964 Some recent developments in factor analysis. Educational and Psychological Measurement, vol 24, no 2, 193-206.

Henrysson, S

1964 Factoranalys av anlagsprov. Rapport nr 7, Pedagogisk-psykologiska institutionen, Lärarhögskolan i Stockholm.

Horn, J L

1967 On subjectivity in factor analysis. Educational and Psychological Measurement, vol 27, no 4, 811-820.

Hurley, J R - Cattell, R B

1962 The procrustes producing direct rotation to test a hypothesized factor structure. Behavioral Sciences, vol 7, 258-261.

Jöreskog, K G

1962 On the statistical treatment of residuals in factor analysis. Psychometrika, vol 27, no 4.

Kaiser, H F

1958 The varimax criterion for analytic rotation in factor analysis. Psychometrika, vol 23, no 3, 187-200.

Kebbon, L - Aldrin, M - Hallerstedt, G

1967 The structure of abilities in the retarded. Scandinavian Journal of Psychology, vol 3, no 3, 150-154.

Kronquist, H

1967 An empirical comparison of six factorization methods. Report no 21 from the Institute of Education, University of Jyväskylä.

Kääriäinen, R- Dingman, H F

1961 The relation of the degree of mongolism to the degree of subnormality. American Journal of Mental Deficiency, vol 65, 438-443.

Kääriäinen, R

1966 Fysiska och psykiska dimensioner inom mongoloismen. In Stukát, K-G & Engström, R (Eds): Samnordisk specialpedagogisk forskning. Rapporter från Pedagogiska institutionen vid Lärarhögskolan i Göteborg, no 2, 28-31.

McCarthy, J J - Olson, J L

1964 Validity studies on the Illinois Test of Psycholinguistic Abilities. University of Illinois, Urbana, Illinois.

McCarthy, J McRae

Patterns of psycholinguistic development of mongoloid and non-mongoloid severely retarded children. University of Illinois, University Microfilms Inc, Ann Arbor, Michigan.

O'Connor N - Hermelin B

1963 Speech and thought in severe subnormality. Pergamon Press, London.

Silverstein, A B - Hill, T V

1967 Comparability of three picture vocabulary tests with retarded school children. Training School Bulletin, vol 64, no 2, 58-61.

Stangvik, G

1968 Billedtolkingsevne hos psykisk utviklingshemmede i IQ-området 30-50. In Stangvik, G (Ed): Förberedande studier rörande läsning av socialt viktiga ord i träningsskolan. Samnordiska projektet i specialpedagogik 1. Rapporter från Pedagogiska institutionen vid Lärarhögskolan i Göteborg, no 8.

Stukát, K-G

1965 Prövning av hypotetisk faktorstruktur hos skolnybörjare. Pedagogisk Forskning, vol 9, 1-16.

Thurstone, L L - Thurstone, T G

1963 Examiner's Manual. Primary Mental Abilities. For grades K-1. Revised 1963. Science Research Associates Inc.

1965 SRA-PMA. Primary Mental Abilities. Technical Report. Science Research Associates Inc.

Wisland, M V - Many, W

1967 A study of the stability of the Illinois Test of Psycholinguistic Abilities. Educational and Psychological Measurement, vol 27, no 2, 367-370.

# 7 APPENDICES

## 7.1 Tests used in the present study

1. Bead Stringing. 18 beads of the sort supplied with the S-B test kit. The test is the same as in Meyers et al 1962, p 23.
2. Line Drawing. Thurstone & Thurstone: SRA-PMA. Primary Mental Abilities. Ages 5-7. Fourth Edition, 1954. See Meyers et al 1962, p 23-24.
3. Peg Board. A modification of the Stromberg Dexterity Test without color discriminations. Stromberg, E L: Stromberg Dexterity Test. Test Catalog. The Psychological Corporation, New York, 1960, p 16.
4. Identical Pictures. Thurstone & Thurstone: Primary Mental Abilities. Ages 5-7. Fourth Edition, 1954. See Meyers et al 1962, p 24.
5. Pacific Perceptual Speed. Same as in Meyers et al 1962, p 25.
6. Form Board. A test developed by the author. Measuring perceptual speed. Consists of 35 wooden forms to be put on their places as quickly as possible.
7. Block Design. Wechsler D: Wechsler Preschool and Primary Scale of Intelligence. Manual. The Psychological Corporation, New York, 1967, p 73.
8. Peabody Picture Vocabulary Test. Dunn, L M. Peabody Picture Vocabulary Test, Form B. American Guidance Service Inc, 1959.
9. Van Alstyne: Expressive. A modification of the Van Alstyne Picture Vocabulary Test, constructed of the right responses of the original test. 60 items. Van Alstyne, D: Van Alstyne Picture Vocabulary Test. Harcourt, Brace & World Inc, 1961.
10. Van Alstyne: Receptive. Van Alstyne, D: Van Alstyne Picture Vocabulary Test. Harcourt, Brace & World Inc, 1961.
11. Monroe. See Meyers et al 1962, p 26.

12. Raven. Coloured Progressive Matrices, Set A and Ab. George C Harrap, London 1956.

13. Pacific Pattern Copying. Same as in Meyers et al 1962, p 27.

14. Auditory Memory. Auditory-Vocal Sequencing Test of ITPA. McCarthy, J J & Kirk, S A: Illinois Test of Psycholinguistic Abilities. Experimental Edition. Examiners Manual. Institute for Research on Exceptional Children, University of Illinois, Urbana, Illinois, 1961, p 50.

15. Visual Memory. Visual-Motor Sequencing Test of ITPA. Same manual as in Harman 1967, p 43.

16. Arithmetic. Wechsler, D: Manual for the Wechsler Preschool and Primary Scale of Intelligence. The Psychological Corporation, New York, 1967, p 60.

17. Q-test. Thurstone & Thurstone: SRA-PMA. Primary Mental Abilities. Ages 5-7. Fourth Edition, 1954. Examiners Manual, p 13-15.

## 7.2 Tables

Reliabilities of the 17 tests used in the present study.

| Test | Speed or power test | $h^2$ | r |
|---|---|---|---|
| 1. Beads | speed | .672 | |
| 2. Lines | speed | .643 | |
| 3. Pegs | speed | | .69 RT |
| 4. Id pict | speed | .925 | .59 RT |
| 5. PPS | speed | .761 | |
| 6. Forms | speed | | .69 RT |
| 7. Blocks | speed & power | | .82 SH |
| 8. PPVT | power | | .67 PT |
| 9. Van A Expres | power | .651 | |
| 10. Van A Recept | power | | .71 SH |
| 11. Monroe | speed | .575 | .62 SH |
| 12. Raven | power | .818 | .76-91 SH, RT |
| 13. PPC | power | .623 | .91 K-R, 90 SH |
| 14. Audit M | power | | .80 SH |
| 15. Visual M | power | | .62 SH |
| 16. Arithmetic | power | | .82 SH |
| 17. Q-test | power | | .65 RT |

$h^2$ = communalities in factor analysis with retarded subjects according to Meyers et al 1962 and Meyers et al 1964.

r = reliability coefficient: RT=re-test, SH=split-half, PT=parallel test, K-R=Kuder-Richardson.

$h^2$ in the test no 9 is taken from the factor results of the present study.

Table 1.

| Variable | Mean | SD |
|---|---|---|
| 1. Beads | 9.73750 | 3.06776 |
| 2. Lines | 30.08749 | 11.64142 |
| 3. Pegs | 30.08749 | 7.47007 |
| 4. Ident Pict | 5.86250 | 3.48865 |
| 5. PPS | 6.82500 | 3.22871 |
| 6. Forms | 16.82500 | 8.26881 |
| 7. Blocks | 10.16250 | 4.52122 |
| 8. PPVT | 53.23749 | 17.79715 |
| 9. Expr VA | 33.93750 | 10.42799 |
| 10. Recept VA | 43.81250 | 8.02852 |
| 11. Monroe | 12.71250 | 5.84220 |
| 12. Raven | 11.05000 | 3.08077 |
| 13. PPC | 25.42499 | 15.95224 |
| 14. Auditory M | 9.83750 | 5.03265 |
| 15. Visual M | 9.06250 | 2.90063 |
| 16. Arithmetic | 7.72500 | 4.01571 |
| 17. Q-test | 11.07500 | 8.37530 |
| Age | 208.450 | 49.895 |
| Factor I | 0.000 | 0.954 |
| Factor II | 0.000 | 0.947 |
| Factor III | 0.000 | 0.932 |
| Factor IV | 0.000 | 0.934 |
| Learning variable | 124.943 | 25.365 |

Table 2. Intercorrelation matrix of the 17 test variables (N=80).

| Test | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | | 508 | 769 | 474 | 412 | 521 | 437 | 482 | 442 | 536 | 275 | 406 | 346 | 178 | 158 | 374 | 427 |
| 2. | | | 596 | 543 | 501 | 442 | 474 | 290 | 338 | 383 | 339 | 322 | 410 | 244 | 268 | 425 | 463 |
| 3. | | | | 486 | 362 | 555 | 491 | 521 | 453 | 565 | 258 | 394 | 457 | 297 | 280 | 571 | 627 |
| 4. | | | | | 653 | 532 | 648 | 446 | 493 | 446 | 337 | 531 | 636 | 197 | 539 | 511 | 587 |
| 5. | | | | | | 481 | 596 | 329 | 395 | 410 | 366 | 467 | 562 | 315 | 381 | 494 | 517 |
| 6. | | | | | | | 719 | 388 | 411 | 423 | 386 | 481 | 502 | 320 | 368 | 524 | 532 |
| 7. | | | | | | | | 432 | 490 | 564 | 336 | 492 | 670 | 296 | 531 | 583 | 609 |
| 8. | | | | | | | | | 706 | 807 | 409 | 302 | 424 | 326 | 320 | 588 | 614 |
| 9. | | | | | | | | | | 734 | 481 | 353 | 411 | 463 | 321 | 568 | 569 |
| 10. | | | | | | | | | | | 425 | 416 | 464 | 434 | 456 | 640 | 658 |
| 11. | | | | | | | | | | | | 158 | 282 | 460 | 236 | 476 | 462 |
| 12. | | | | | | | | | | | | | 596 | 314 | 408 | 412 | 438 |
| 13. | | | | | | | | | | | | | | 324 | 475 | 566 | 632 |
| 14. | | | | | | | | | | | | | | | 269 | 620 | 564 |
| 15. | | | | | | | | | | | | | | | | 501 | 561 |
| 16. | | | | | | | | | | | | | | | | | 890 |
| 17. | | | | | | | | | | | | | | | | | |

Table 3.

| Test | Eigenvalues | Cumulative % of eigenvalues | % of trace |
|---|---|---|---|
| 1. | 8.49196 | 0.49953 | 49.9 |
| 2. | 1.50730 | 0.58819 | 8.8 |
| 3. | 1.28745 | 0.66392 | 7.5 |
| 4. | 0.93610 | 0.71899 | 5.4 |
| 5. | 0.77481 | 0.76457 | 4.5 |
| 6. | 0.68681 | 0.80497 | 4.0 |
| 7. | 0.61548 | 0.84117 | 3.5 |
| 8. | 0.49361 | 0.87021 | 2.8 |
| 9. | 0.42084 | 0.89496 | 2.4 |
| 10. | 0.39806 | 0.91838 | 2.2 |
| 11. | 0.32200 | 0.93732 | 1.8 |
| 12. | 0.28903 | 0.95432 | 1.6 |
| 13. | 0.22420 | 0.96751 | 1.2 |
| 14. | 0.19430 | 0.97894 | 1.1 |
| 15. | 0.14263 | 0.98733 | 0.8 |
| 16. | 0.11844 | 0.99429 | 0.6 |
| 17. | 0.09667 | 0.99998 | 0.5 |

**Table 4. Cattell's scree-test**

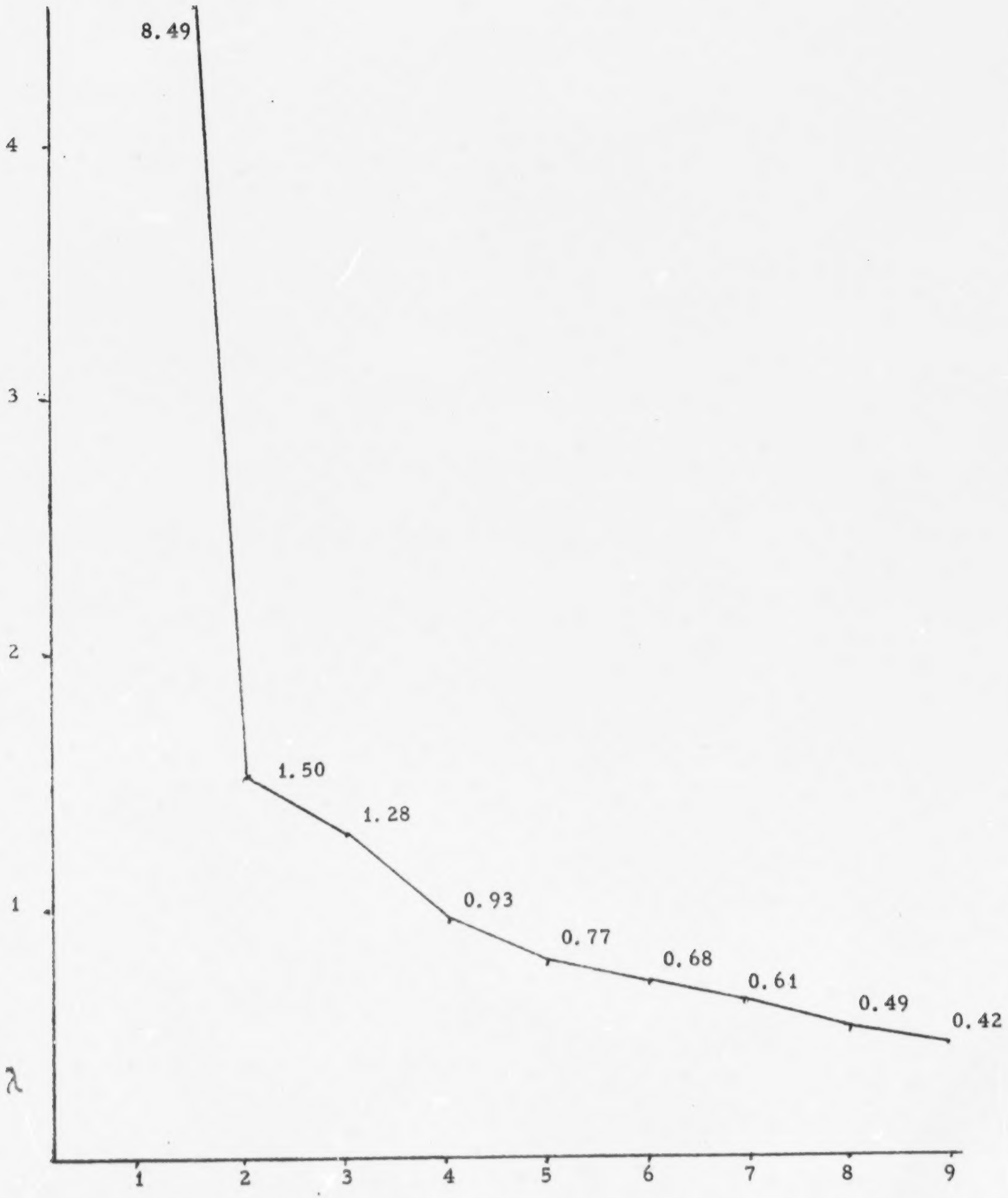

Table 5 a.



| Test | Eigenvalues | Cumulative % of trace | % of trace |
|---|---|---|---|
| 1. | 8.1692 | 74.2709 | 74.2 |
| 2. | 1.1458 | 84.6881 | 10.4 |
| 3. | 0.9524 | 93.3469 | 8.8 |
| 4. | 0.5432 | 98.2858 | 4.9 |
| 5. | 0.3928 | 0.0000 | - |
| 6. | 0.2710 | - | - |
| 7. | 0.2279 | - | - |
| 8. | 0.0840 | - | - |
| 9. | 0.0360 | - | - |
| 10. | 0.0004 | - | - |
| 11. | -0.0317 | - | - |
| 12. | -0.0611 | - | - |
| 13. | -0.0963 | - | - |
| 14. | -0.1218 | - | - |
| 15. | -0.1561 | - | - |
| 16. | -0.1619 | - | - |
| 17. | -0.1947 | - | - |

The sum of the first four eigenvalues = 10.8106

Table 5.b. Normalized unrotated factor loadings.

| Variable | 1 | 2 | 3 | 4 | $h^2$ |
|---|---|---|---|---|---|
| 1. | -.638 | -.106 | -.564 | -.550 | .740 |
| 2. | -.601 | -.215 | -.196 | -.200 | .486 |
| 3. | -.725 | -.473 | -.451 | -.195 | .771 |
| 4. | -.749 | -.326 | .532 | .158 | .696 |
| 5. | -.664 | -.266 | .114 | -.162 | .525 |
| 6. | -.702 | -.227 | -.551 | -.111 | .560 |
| 7. | -.781 | -.270 | .116 | .992 | .707 |
| 8. | -.701 | .400 | -.174 | .289 | .767 |
| 9. | -.708 | .336 | -.644 | .181 | .651 |
| 10. | -.787 | .347 | -.119 | .263 | .824 |
| 11. | -.518 | .237 | .783 | -.152 | .354 |
| 12. | -.597 | -.262 | .837 | .959 | .441 |
| 13. | -.720 | -.248 | .204 | .912 | .630 |
| 14. | -.522 | .330 | .246 | -.295 | .530 |
| 15. | -.566 | -.106 | .327 | .152 | .463 |
| 16 | -.821 | .234 | .224 | -.223 | .830 |
| 17. | -.859 | .162 | .190 | -.164 | .828 |

$\Sigma\ h^2 = 10.803$

Table 5 c. Promax oblique primary factor loadings.

| Variable | I | II | III | IV |
|---|---|---|---|---|
| 1 | -.015 | -.191 | .861 | .187 |
| 2 | .229 | .135 | .529 | -.117 |
| 3 | -.059 | .111 | .816 | .063 |
| 4 | .838 | -.157 | .082 | .074 |
| 5 | .654 | .104 | .079 | -.107 |
| 6 | .449 | .142 | .335 | -.115 |
| 7 | .795 | .000 | .036 | .038 |
| 8 | -.009 | .008 | .098 | .821 |
| 9 | .059 | .116 | .048 | .622 |
| 10 | .105 | .063 | .079 | .754 |
| 11 | -.063 | .532 | .056 | .102 |
| 12 | .676 | -.064 | .035 | .011 |
| 13 | .798 | .062 | -.080 | .004 |
| 14 | -.144 | .872 | -.078 | -.035 |
| 15 | .705 | .120 | -.327 | .101 |
| 16 | .129 | .794 | -.006 | .042 |
| 17 | .241 | .665 | .023 | .072 |

Table 6 a. Correlations among oblique primary factors.

| Factor | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 | 1.0000 | .6664 | .6419 | .5339 |
| 2 | .6664 | 1.0000 | .5347 | .6510 |
| 3 | .6419 | .5347 | 1.0000 | .5098 |
| 4 | .5339 | .6510 | .5098 | 1.0000 |

Table 6 b. Normalized unrotated factor loadings.

| Factor | I | II | III | IV |
|---|---|---|---|---|
| 1 | -.857 | -.240 | -.322 | .319 |
| 2 | -.861 | .243 | -.292 | -.337 |
| 3 | -.802 | -.467 | .333 | -.161 |
| 4 | -.806 | .461 | .323 | .180 |

Table 6 c. Orthogonal factor matrix (Varimax).

| Factor | I | II | III | IV |
|---|---|---|---|---|
| 1 | .222 | .315 | .299 | .872 |
| 2 | .321 | .223 | .868 | .302 |
| 3 | .215 | .912 | .202 | .281 |
| 4 | .911 | .217 | .285 | .203 |

Table 7 a. 3-factor solution. Promax oblique primary factor loadings.

| Variable | Factor I | Factor II | Factor III |
|---|---|---|---|
| 1. | .04 | .02 | .81 |
| 2. | .40 | -.03 | .39 |
| 3 | .10 | .16 | .69 |
| 4 | .76 | -.04 | .14 |
| 5 | .70 | -.00 | .04 |
| 6 | .56 | .02 | .24 |
| 7 | .76 | .04 | .06 |
| 8 | -.19 | .76 | .30 |
| 9 | -.04 | .71 | .18 |
| 10 | -.05 | .74 | .26 |
| 11 | .06 | .54 | -.01 |
| 12 | .64 | -.03 | .06 |
| 13 | .77 | .06 | -.05 |
| 14 | .07 | .69 | -.22 |
| 15 | .62 | .19 | -.25 |
| 16 | .31 | .70 | -.11 |
| 17 | .39 | .62 | -.06 |

Table 7 b. 5-factor solution. Promax oblique primary factor loadings.

| Variable | Factor I | Factor II | Factor III | Factor IV | Factor V |
|---|---|---|---|---|---|
| 1. | -.02 | .18 | .82 | -.16 | .02 |
| 2. | .21 | -.16 | .44 | .05 | .22 |
| 3. | -.07 | .04 | .90 | .20 | -.17 |
| 4. | .81 | .07 | .02 | -.17 | .11 |
| 5. | .64 | -.09 | -.04 | -.01 | .32 |
| 6. | .43 | -.10 | .27 | .07 | .19 |
| 7. | .77 | .04 | .00 | -.02 | .10 |
| 8. | .00 | .81 | .11 | .00 | .00 |
| 9. | .06 | .63 | -.04 | .03 | .28 |
| 10. | .10 | .74 | .09 | .06 | .00 |
| 11. | -.04 | .12 | -.11 | .27 | .53 |
| 12. | .65 | .00 | .07 | .00 | -.08 |
| 13. | .77 | .00 | -.03 | .10 | -.05 |
| 14. | -.12 | -.02 | -.10 | .69 | .31 |
| 15. | .69 | .09 | -.23 | .18 | -.13 |
| 16. | .13 | .03 | .08 | .75 | .03 |
| 17. | .24 | .06 | .14 | .67 | -.05 |

Table 7 c. 6-factor solution. Promax oblique primary factor loadings.

| Variable | Factor I | Factor II | Factor III | Factor IV | Factor V | Factor VI |
|---|---|---|---|---|---|---|
| 1 | -.03 | .19 | .76 | -.17 | .06 | .16 |
| 2 | .14 | -.17 | .41 | .07 | .42 | -.04 |
| 3 | -.05 | .04 | .85 | .18 | -.07 | .03 |
| 4 | .70 | .08 | .02 | -.18 | .39 | -.09 |
| 5 | .54 | -.09 | -.04 | .00 | .45 | .03 |
| 6 | .43 | -.11 | .23 | .09 | .01 | .45 |
| 7 | .74 | .04 | -.01 | -.02 | .06 | .27 |
| 8 | .00 | .86 | .10 | .00 | -.03 | -.09 |
| 9 | .05 | .67 | -.05 | .06 | .15 | .04 |
| 10 | .11 | .79 | .09 | .05 | -.05 | -.02 |
| 11 | -.08 | .14 | -.11 | .34 | .40 | .07 |
| 12 | .64 | .00 | .06 | -.02 | -.09 | .22 |
| 13 | .74 | .00 | -.03 | .08 | .03 | .06 |
| 14 | -.09 | -.02 | -.10 | .75 | .05 | .13 |
| 15 | .65 | .09 | -.21 | .16 | .00 | -.10 |
| 16 | .15 | .03 | .08 | .77 | .00 | -.06 |
| 17 | .24 | .06 | .14 | .68 | .01 | -.15 |

Table 8.

| Variable | Learning variable (N=53) | Age (N=80) |
|---|---|---|
| 1. Beads | .148 | .165 |
| 2. Lines | .177 | .141 |
| 3. Pegs | .254 | .216 |
| 4. Ident Pict | .379 | .018 |
| 5. PPS | .322 | .003 |
| 6. Forms | .180 | .097 |
| 7. Blocks | .378 | .126 |
| 8. PPVT | .350 | .207 |
| 9. Expr VA | .211 | .291 |
| 10. Recept VA | .313 | .234 |
| 11. Monroe | .188 | .129 |
| 12. Raven | .272 | .145 |
| 13. PPC | .467 | .173 |
| 14. Auditory M | .183 | .043 |
| 15. Visual M | .203 | -.047 |
| 16. Arithmetic | .453 | .188 |
| 17. Q-test | .353 | .096 |
| Age | .144 | - |
| Factor I | .472 | .107 |
| Factor II | .393 | .165 |
| Factor III | .254 | .204 |
| Factor IV | .328 | .246 |
| Learning variable | - | |

Table 9 a. Male, N=41.

| Means of this group | | SD of this group |
|---|---|---|
| F I | 0.153 | 0.996 |
| F II | 0.245 | 1.020 |
| F III | 0.085 | 1.038 |
| F IV | 0.322 | 0.928 |

Determinant D = 0.0713

Table 9 b. Female, N=39.

| Means of this group | | SD of this group |
|---|---|---|
| F I | -0.161 | 0.905 |
| F II | -0.257 | 0.813 |
| F III | -0.089 | 0.823 |
| F IV | -0.339 | 0.837 |

Determinant D = 0.0289

Table 9 c.

| Means of total sample | | SD for total sample |
|---|---|---|
| F I | 0.000 | 0.960 |
| F II | 0.000 | 0.953 |
| F III | 0.000 | 0.937 |
| F IV | 0.000 | 0.940 |

Determinant W = 2124964.000

H 1: F = 1.636 $p \leq .10$

Determinant T = 2496516.000

Lambda = 0.8511

H 2: F = 3.278 $p \leq .025$

Table 10 a. Open care, N=31.

| Means of this group | | SD of this group |
|---|---|---|
| F I | 0.087 | 0.833 |
| F II | 0.074 | 1.009 |
| F III | -0.030 | 0.863 |
| F IV | 0.150 | 0.774 |

Determinant D = 0.0931

Table 10 b. Institutionalized, N=49

| Means of this group | | SD of this group |
|---|---|---|
| F I | -0.055 | 1.037 |
| F II | -0.047 | 0.924 |
| F III | 0.019 | 0.990 |
| F IV | -0.095 | 1.028 |

Determinant D = 0.0296

Means of total sample and SD for total sample, see Table 9 c.

Determinant W = 2395227.000

H 1: F=2.497 $p < .01$

Determinant T = 2496492.000

Lambda = 0.9594

H 2: F = 0.7927 N S

Table 11 a. Mongoloid, N=24.

| Means of this group | | SD of this group |
|---|---|---|
| F I | -0.383 | 0.751 |
| F II | -0.533 | 0.650 |
| F III | -0.571 | 0.630 |
| F IV | -0.444 | 0.801 |

Determinant D=0.0100

Table 11 b. Non-mongoloid, N=56.

| Means of this group | | SD of this group |
|---|---|---|
| F I | 0.164 | 0.998 |
| F II | 0.228 | 0.975 |
| F III | 0.245 | 0.945 |
| F IV | 0.190 | 0.937 |

Determinant D=0.0610

Means of total sample and SD for total sample, see Table 9 c.

Determinant W = 1977849.0000
H 1: F = 2.8923 $p < .005$

Determinant T = 2496523.0000
Lambda = 0.792
H 2. F = 4.9170 $p < .005$

Table 12. Means.



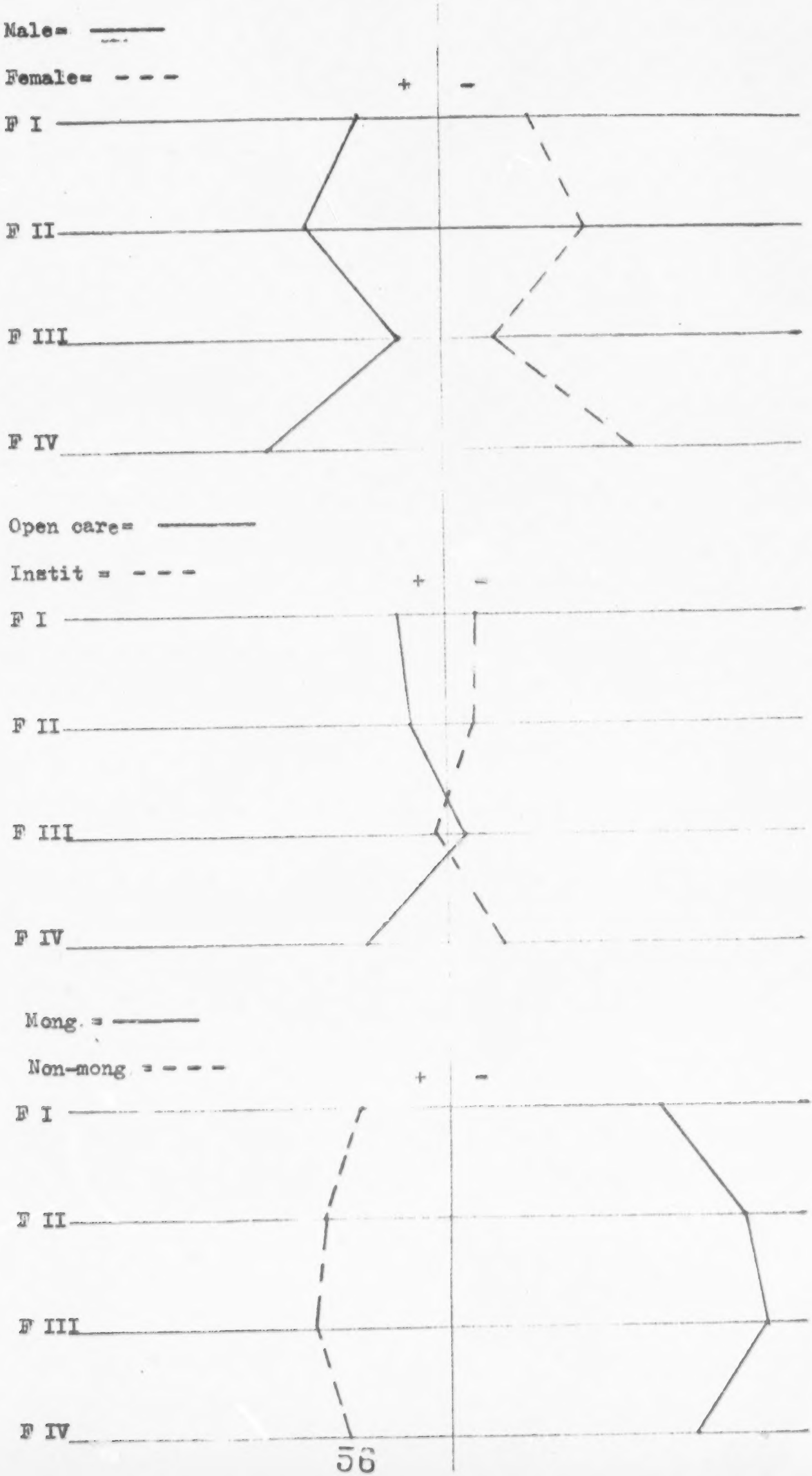

Table 13 a.

| Variable | Mean | Standard Deviation | Correlation X vs Y | Regression Coefficient | Std Error of Reg Coef | Computed t value |
|---|---|---|---|---|---|---|
| 1 | 9.301 | 2.945 | -.148 | 2.380 | 2.171 | 1.096 |
| 2 | 29.641 | 10.362 | -.177 | 0.401 | 0.580 | 0.691 |
| 3 | 28.490 | 5.645 | -.254 | -1.499 | 1.295 | -1.157 |
| 4 | 5.188 | 2.889 | -.379 | -2.157 | 1.935 | -1.115 |
| 5 | 6.245 | 2.615 | -.322 | -0.396 | 1.925 | -0.206 |
| 6 | 15.679 | 6.849 | -.180 | 0.698 | 0.824 | 0.846 |
| 7 | 9.509 | 3.993 | -.378 | -1.339 | 1.477 | -0.906 |
| 8 | 51.377 | 17.160 | -.350 | -0.288 | 0.467 | -0.617 |
| 9 | 33.433 | 9.126 | -.211 | 0.512 | 0.674 | 0.760 |
| 10 | 42.245 | 7.413 | -.313 | -0.345 | 1.175 | -0.294 |
| 11 | 12.716 | 5.565 | -.188 | -0.587 | 0.756 | -0.776 |
| 12 | 10.283 | 1.758 | -.272 | -0.796 | 2.639 | -0.301 |
| 13 | 21.490 | 13.368 | -.467 | -0.496 | 0.336 | -1.478 |
| 14 | 9.339 | 4.150 | -.183 | 0.275 | 1.055 | 0.261 |
| 15 | 8.773 | 2.374 | -.203 | -0.143 | 2.037 | -0.070 |
| 16 | 6.867 | 2.935 | -.453 | -3.267 | 2.314 | -1.411 |
| 17 | 8.943 | 6.178 | -.353 | 1.636 | 1.297 | 1.261 |
| Dependent | | | | | | |
| 18 | 124.943 | 25.608 | | | | |

Table 13 b

| | | |
|---|---|---|
| Intercept = | 194.212 | |
| Multiple correlation = | .641 | $F^{16}_{32} = 1.395$ N S |
| Std error of estimate = | 23.948 | |

Table 13 c. Analysis of variance for the regression.

| Source of variation | Degrees of freedom | Sum of squares | Mean squares | F value |
|---|---|---|---|---|
| Attributable to regression | 17 | 14026.773 | 825.104 | 1.438 N S |
| Deviation from regression | 35 | 20073.972 | 573.541 | |
| Total | 52 | 34100.742 | | |

N = 53

Table 14 a

The last phase of the selective regression analysis (stepwise linear regression):

| | | |
|---|---|---|
| Dependent variable | Krit | |
| Residual SD | 21.9839 | |
| Stand error of the mean | 3.0197 | |
| Multiple R | .6135 | F= 3.707 p≤.01 |
| Multiple Rs QR | .3764 | |
| Variable entered | 7 | |

| Variable | B-coef | STD er of B | Partial R | Beta-coef | STD er of Beta |
|---|---|---|---|---|---|
| 4 | -1.9431 | 1.4120 | -.2031 | -.2192 | .1593 |
| 6 | 0.7830 | 0.6054 | .1913 | .2094 | .1619 |
| 7 | -1.2641 | 1.1580 | -.1623 | -.1971 | .1805 |
| 8 | -0.4500 | 0.2956 | -.2236 | -.3015 | .1981 |
| 9 | 0.5084 | 0.4847 | .1561 | .1812 | .1727 |
| 13 | -0.5097 | 0.2905 | -.2557 | -.2661 | .1516 |
| 16 | -4.2098 | 1.9134 | -.3148 | -.4825 | .2193 |
| 17 | 1.8096 | 1.0276 | .2565 | .4365 | .2479 |

Constant 164.5747

Table 14 b. Analysis of variance table.

| Source | D F | Sum of squares | Mean square | F |
|---|---|---|---|---|
| Mean | 1 | 0.82737 | 0.82737 | |
| Regression | 8 | 0.12835 | 0.16044 | 0.33198 |
| Error | 44 | 0.21264 | 0.48329 | |

Table 15.

The regression equation for the standard scores of all variables used as predictors:

$$Z'_{18} = .273z_1 + .162z_2 - .330z_3 - .243z_4 - .040z_5 + .186z_6$$
$$-.208z_7 - .193z_8 + .182z_9 - .099z_{10} - .127z_{11} - .054z_{12}$$
$$-.259z_{13} + .044z_{14} - .013z_{15} - .374z_{16} + 394z_{17}$$

The regression equation for the standard scores of the selected 8 variables used as predictors:

$$z'_{18} = -.219z_4 + .209z_6 - .197z_7 - .301z_8 + 181z_9 - .266z_{13}$$
$$-.482z_{16} + .436z_{17}$$

Department of Educational Research
Gothenburg School of Education
Research Bulletins:

1. Levin, L. Implicit and Explicit – A Synopsis of Three Parallel Experiments in Applied Psycholinguistics Assessing Different Methods of Teaching Grammatical Structures in English as a Foreign Language. The GUME Project. December 1969.

2. Klingberg, G. The Fantastic Tale for Children. A Genre Study from the Viewpoints of Literary and Educational Research. February 1970.

3. Kaarilainen, R. The Factor Structure of Intellectual Abilities and Signal Sight Vocabulary Learning at Moderate and Severe Levels of Preliterate Mental Retardation. The Scandinavian Research Group on Special Education. June 1970.